PulpIng – Development of Pumpkin Pulp Formulation Using a Sustainable Integrated Strategy

PRIMA-Section 2 project (2019)

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Executive Summary

Background	In the Pulping project, a comprehensive and meticulous characterization of the encapsulated bioactive compounds holds paramound significance. Accurate characterization ensures quality control by verifying the integrity of the encapsulated compounds, including parameters such as encapsulation efficiency, particle size distribution, physicochemical parameters, and biological activities. The optimizing of the stabilization technique and assessment of the stability of the bioactive compounds, are crucial to select a stabilization technique that preserves the compounds activities and protects them from degradation. Furthermore, characterization contributes to optimizing the formulation by selecting suitable carriers, and adjusting particle sizes, ensuring the effectiveness of the stabilization technique. Finally, characterization drives innovation by providing a scientific foundation for the development of a sustainable integrated strategy for preserving bioactive compounds in pumpkin, advancing food preservation methods and enhancing the overall quality of the product.
Objectives	In previous tasks and deliverables of the project, Squash landraces Batati (NGBTUN 746) peels was selected for encapsulation considering its important biological activities. To preserve these activities, refined extract were carefully encapsulated in suitable delivery systems compatible with food applications. The objective of this deliverable is to assess the physicochemical and biological attributes of encapsulated bioactive compounds.
Methodology	Squash landraces Batati (NGBTUN 746) refined peel extract were encapsulated as detailed in D 3.3. The evaluation of the encapsulated refined extract used a methodology that cover physicochemical, antioxidant, and antimicrobial analyses. Physicochemical characterization involved viscosity measurement in mPa/s and pH determination. Turbidity was quantified and color attributes (L, a, b) were recorded. Additionally, antioxidant assessment, the ABTS and DPPH assays measured radical-scavenging potential, while total antioxidant activity and polyphenol content were quantified colorimetrically in mgGAE/gDR. Simultaneously, the antibacterial profile was investigated using growth Inhibition Percent (PI) against bacterial strains. PI values represented susceptibility as percentages. ***Statistical analysis.*** For all tests, at 3 to 6 replicates were used. Means were compared using the Newman-Keuls (SNK) test at a level of $p < 0.5$ when significant differences were found by the statistical package SAS 9.1 (2002, 525).

Results and implications

Considering previous results, the adopted software concluded that the targeted limit can be achieved with 91% desirability using a mixture consisting of **23.8% Maltodextrin+ 27.7% Arabic gum+48.5% refined extract.**

Once formulation was statistically validated, the optimized encapsulated refined extracts was characterized for various parameters either physicochemical (pH, viscosity, turbidity, color) or biological (antioxidant and antibacterial activities) as detailed in bellow. Considering the physicochemical parameters **(Table 1),** the viscosity of the encapsulated extract is 17 mPa/s with a negligible variation of ± 0.01. The pH of the extract is 4.2, showing a slight fluctuation of ± 0.23. Color measurements include L (lightness) at 102.4, a (redness) at 3.5, and b (yellowness) at 7.8. Turbidity is 0.412. The units for viscosity are millipascal-seconds (mPa/s), pH is unitless, color values are without units, and turbidity is unitless.

Table 1. Physicochemical parameters of refined extracts.

	Results	**Units**
Viscosity	17± 0.01	mPa/s
pH	4,2± 0.23	-
Color : L	102.4	-
Color : a	3.5	-
Color : b	7.8	-
Turbidity	0,412± 0.05	-

The encapsulated refined extract's biological characterization presented in **Table 2**, reveal its important composition (total polyphenol content), antioxidant potential and antiradical activity. The ABTS level of 53.9% demonstrates significant radical scavenging ability. With a total antioxidant activity of 4.2 mgGAE/gDR, the extract exhibits noteworthy capacity to counteract oxidants, which can have positive health implications. The total polyphenol content of 37.2 mg GAE/gDR emphasizes the abundance of encapsulated antioxidative compounds. Additionally, the encapsulated extract's antiradical activity of 44.2% underscores its efficacy in mitigating radical-induced damage. Despite minor fluctuations in some measurements, the collective findings strongly suggest that the encapsulated extract possesses robust antioxidant attributes.

Table 2. Biological characterization of refined extracts.

	results	Units
ABTS	53.89± 0.07	%
Total antioxidant activity	4.19± 0.06	mgGAE/gDR
Total polyphenol content	37.2± 1.52	mg GAE/g DR
Antiradical activity	44.2± 2.04	%

Switching to antibacterial potency, (**Table 3**) provides the growth Inhibition Percent (PI) of encapsulated refined extract against various bacterial strains. *Enterococcus faecalis* exhibits a PI of 84%, demonstrating its sensitivity to the tested agent. *Pseudomonas aeruginosa* also shows notable sensitivity, with a PI of 85%. *Salmonella typhimurium* records the highest sensitivity at 89%, while *Staphylococcus aureus* displays a lower sensitivity, registering a PI of 38%.

Table 3. Inhibition Percent (PI) of encapsulated refined extract.

	PI (%)
Enterococcus faecalis	84,06
Pseudomonas aeruginosa	84,76
Salmonella thyphimurium	89,43
Staphylococcus aureus	38,45

All these attributes hold promise for diverse applications, including functional foods and nutraceuticals, where harnessing its potential could contribute to enhanced health benefits.